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AN INVESTIGATION OF BENZENE SOLUBLE ORGANICS IN DUSTFALLS COLLECTED IN OSHAWA AND CHATHAM

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ABSTRACT

Dustfall samples originating from three locations in Oshawa and from two locations in Chatham, both close to local industries, were analyzed for Benzene Soluble Organics (BSO). The analytical results covering test periods of 18 months and 11 months, respectively, indicated the presence of BSO at concentrations from below 1% to over 8% in the dustfall solids. The results also indicated that certain periodic changes in these relative BSO contents occurred in both cities during the year. Some of the Oshawa samples were also analyzed for five polynuclear aromatic hydrocarbons with only insignificantly small amounts of these compounds found in the BSO. Because of limited data and lack of background information, no attempts were made to link the BSO levels with emissions from industries in the respective areas.

INTRODUCTION

The analysis for Benzene Soluble Organics (BSO) in monthly dustfall samples had been included in the Air Quality Survey Plan - Central Region (reissue date January 27, 1976). Dustfall stations #45014, 45015 and 45019, all located in Oshawa in the vicinity of Fittings Limited (an iron foundry with coking operations) had been selected to provide dustfall samples for investigating the BSO levels in this area. Samples from another station (#45039), located in the same general area, have more recently been added for analysis. The locations of these stations are shown on the map in Figure 1.

Upon request by West Central Region, analyses for BSO have been carried out also on dustfall samples from stations #13004 and 13005, both located close together in Northwesterly direction from Rockwell International Company (a user of quenching oils for metal parts) in Chatham. Complaints about irritating aerosol contaminations and fallouts in the neighbourhood of this Company have frequently been received from residents of this area. The location of the dustfall sampling sites in Chatham are shown on the map in Figure 2.

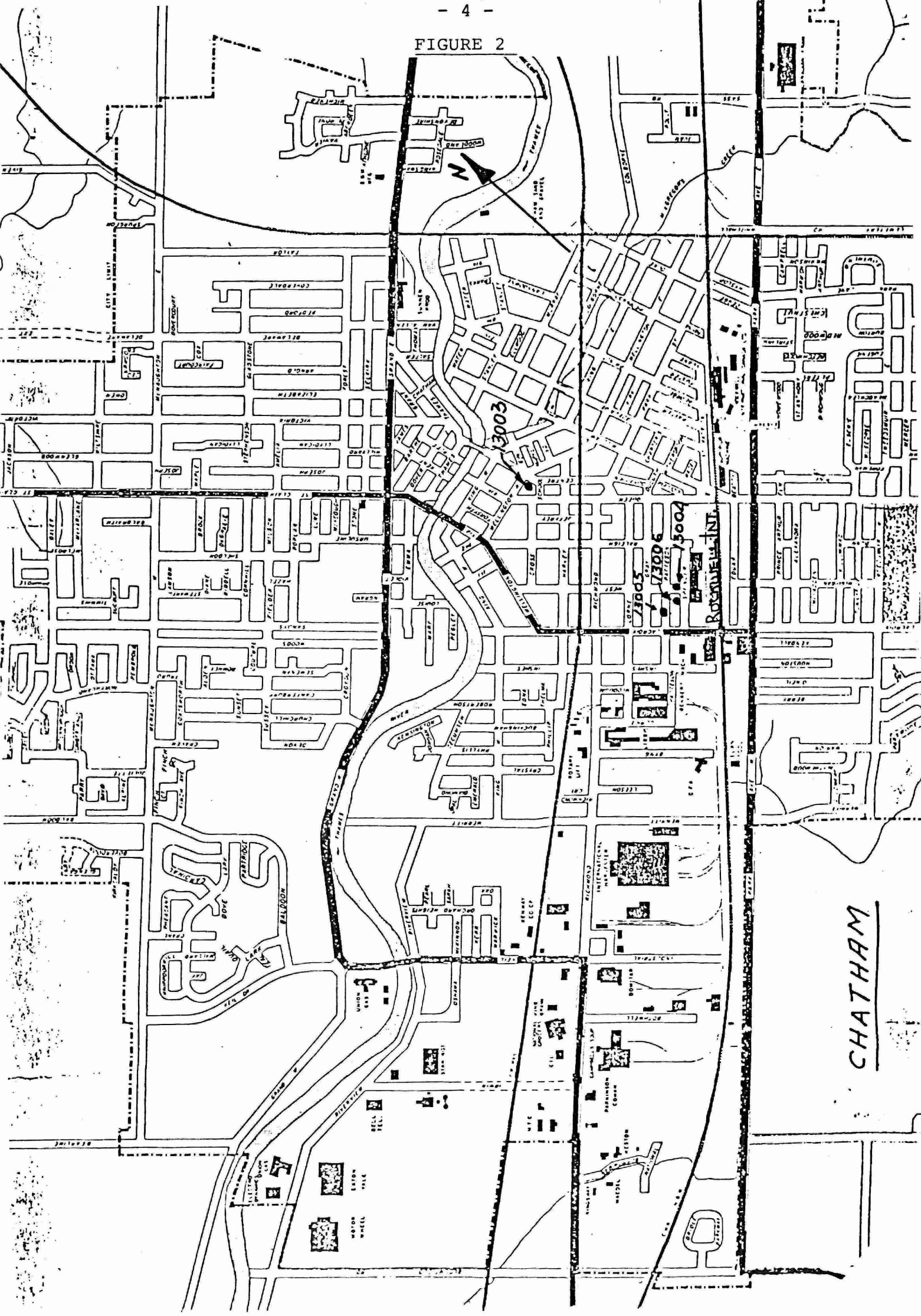
SAMPLING

At the dustfall stations indicated, sampling was carried out by exposing open plastic containers of 6 inch in diameter and

FIGURE 1


45035
45019
OSHAWA
45014
FITTINGS LTD
45015
HARMON
WILSON ROAD
CANADIAN PACIFIC
CEDAR DALE
FITTINGS, OSHAWA SURVEY
OSHAWA
ONTARIO
Scale 1:25,000 Échelle
Miles

FIGURE 2



12 inch tall to the atmosphere during consecutive periods of one calender month. The settled particulate in the containers was, after screening to remove any extraneous material, recovered by filtration with the use of a tared paper filter on a Buchner funnel. The weight of the insoluble matter (particulate) was determined by drying the filter in a drying oven at 105 °C to constant weight and establishing the weight difference from the tare. Then, the soluble matter in the filtrate was determined by evaporation on a hot plate to near dryness, followed by completely drying the solid residue in a drying oven at 105 °C, and determining the weight of the residue. The combined weights of the insoluble and the soluble matter, representing the total dustfall solids in the sample, has been determined with the lowest detectable limit of the method being 0.1 mg of dustfall solids per sample.

ANALYTICAL

Benzene Soluble Organics (BSO) in dustfall samples were determined by extracting both the insoluble and the soluble portions of the solids in these samples. This was done by first dispersing the dried soluble portion of the sample in about 20 ml of reagent-grade benzene and by shaking the resulting slurry for about 10 minutes at room temperature. Then, the filter paper with the insoluble portion of the sample was carefully folded and placed into an extraction thimble already located inside a micro-soxhlet apparatus.

The benzene extract of the soluble portion was subsequently poured into the thimble, followed by the addition of a sufficient amount of pure benzene for carrying out the Soxhlet extraction. The benzene extract collected in the extraction flask after an extraction period of 6 to 8 hours was blown down to dryness with dry air at room temperature. The weight of the residue, or BSO, was determined by the weight difference of the extraction flask before and after extraction.

RESULTS AND DISCUSSION

a) Samples from Oshawa

Dustfall data from samples collected in Oshawa over an 18-month period (December 1976 to June 1978) showed peaks in the levels for dustfall solids for the month of March 1977 at all three stations investigated (#45014, 45015 and 45019). Total fallout volume (which includes precipitation) was generally highest in September 1977 at all three stations. Otherwise, there were no periodic or seasonal trends in dust levels observable (Figures 3 to 5; Tables 1 to 3).

It also became apparent that the dust levels at station #45014 were about twice as high (in their average as well as their maximum/minimum values) as those at the other two stations,

which could suggest proximity of the high-level station to a major emission source. However, as shown in Figure 1, station #45014 as well as station #45015 were about equally close to and in similar direction from Fittings Limited, while only station #45019 was somewhat further away. This seemed to reduce the possibility that Fittings Limited was the main source for the high dust levels at station #45014.

The results from the BSO analysis indicated that periodic (or seasonal) fluctuations of the BSO levels in the dustfall solids coincided at all three stations in Oshawa (Figures 6 to 8). Thus, the BSO levels showed peaks for the months of December, April and August, which were followed closely by lows in the months of January, May and September. It appears that regardless of the two-times higher dust levels at station #45014 (than at the other two stations), the proportions of BSO in the dust followed the same periodic fluctuations at all three locations. This would suggest that the BSO in the dust and the nature of their sources were the same at these locations even during the afore-mentioned periodic fluctuations in their levels (A minor exception to this periodicity in BSO levels was found for station #45019 at the end of the 18-month testing period).

The BSO in the monthly dustfall solids ranged between 0.6 and 5.6% for the three Oshawa stations (Table 6). The average BSO

level at each station during the 18-month period was in the close range of 2.3 to 3.0% inspite of wide fluctuations in total dustfall solids at these stations.

Owing to the lack of "background" data for BSO levels at locations more distant from Fittings Limited, and to lack of knowledge of production schedules, the influence of emissions from this industry upon the BSO levels in its vicinity cannot be assessed.

After the recent addition of a fourth station (#45035), located in the immediate vicinity East of Fittings Limited, a very high level of total dustfall solids was found for March 1978 (Table 3). With a BSO concentration of only 0.6% based on the total dustfall solids, no conclusions can yet be drawn from these isolated results.

b) PAH in Oshawa Dustfall Samples

An exploratory investigation was made to determine polynuclear aromatic hydrocarbons (PAH) in some dustfall solids discussed in this study. The BSO extracts from dustfall samples collected in December 1976 and January 1977 at the three Oshawa stations #45014, 45015 and 45019 were analyzed for five PAH compounds. By using high performance liquid chromatography with a "Vydac" reversed phase column and with aqueous 75% acetonitrile serving as the liquid phase, benzo (a) pyrene (BaP), benzo (k) fluoranthene (BkF), benzo (ghi) perylene (B(ghi)P),

fluoranthene and perylene were separated and quantitatively determined.

The results, shown in Table 7, indicated that these five PAH compounds accounted for only 0.02 to 0.11% of the BSO in these dustfall samples. The portions of "total" PAH, which would include all PAH compounds in these samples, are expected to be multiples of these percentages.

The results also indicated that there was consistently a larger amount of PAH present in the December samples than in the January samples. This was in agreement with higher BSO levels found for December at all three stations. The amounts of PAH in the samples from station #45014 were by far the largest of all three stations during both months, which was in line with high levels of BSO and dustfall solids at that station. Fluoranthene and perylene were the most predominant PAH compounds of those analyzed with the carcinogenic BaP being third in line. However, the total amounts of these compounds being only in the low ug-range for a full month's dustfall - sampling could hardly be considered as significant.

c) Samples from Chatham

The total solids in dustfall samples collected at stations #13004 and 13005 in Chatham over an 11-month period (July 1977 to June 1978) were found to be completely unrelated for these

two stations during this time period. In fact, while at station #13004 the dustfall low (17 mg) occurred in February 1977, the highest level of dust (917 mg) was found for the same month at station #13005 (Figures 9 and 10; Tables 4 and 5). This large difference between the amounts of dustfall solids at these two stations appeared to be particularly surprising as both dustfall stations were located at the short distance of just one city-block Northwest of Rockwell International Company in Chatham (Figure 2). As in Oshawa, the total dustfall volume (which includes precipitation) was found to be highest in December 1977 at both stations.

By contrast to the divergent amounts of total dustfall solids collected at the two Chatham stations, the BSO concentrations showed distinct peaks during the periods August/September 1977 and January/February 1978, as shown in Figures 11 and 12. The BSO levels were generally higher than in Oshawa, ranging between 1.1 and 37.9 mg per monthly dustfall. By comparison, the range of BSO levels found at the three Oshawa stations was only 0.7 to 9.3 mg per monthly dustfall (Table 6).

It remains to be seen whether the trends in BSO levels in Chatham as well as in Oshawa, as apparent in this preliminary investigation, were "genuine" and would continue in successive years. Their possible causes might be uncovered if the scope of this study could be expanded by including further dustfall sampling points at locations inside and outside of these two

cities. Because of insufficient data and lack of background information, speculation on the contribution of local industrial emissions to the BSO levels in the respective areas appears to be futile at the present time.

CONCLUSIONS AND RECOMMENDATIONS

1) The BSO contents in dustfall samples which originated from three locations in Oshawa and from two locations in Chatham were determined over time periods of 18 and 11 months, respectively.

2) While the dustfall solids in the samples from both cities showed no distinct seasonal trends, the corresponding BSO levels showed peaks during the months of December, April and August at Oshawa, and during August/September and January/February at Chatham. The existence of these trends would have to be verified by continuation of this investigation over several years.

3) The BSO determined in monthly dustfalls was found to be higher at Chatham, with amounts ranging from 1.1 to 37.9 mg versus 0.7 to 9.3 mg at Oshawa.

   The analysis for polynuclear aromatic hydrocarbons in some samples from Oshawa indicated the presence of five such compounds at amounts only in the low microgram range.

With the total PAH compounds in dustfall sample estimated to hardly exceed 1% of the BSO, it would be of interest to know the chemical identities of the major components of BSO. Knowledge of these components might help to trace the sources of the BSO and the dust.

4) Because of the lack of any data from "background" samples, i.e. from sampling sites located further away from the two industries mentioned, and of the absence of any information pertaining to the production schedules at these industries during the time period investigated, no conclusions regarding the effect on dustfall and BSO levels from these industries are presently possible. It is recommended to continue monitoring the BSO levels in dustfall at the sites selected for at least another 18 months and to add to this survey sampling-sites which could serve as background stations for measuring industrial dust and BSO emissions.

5) For the analysis of oily fallouts and aerosols in the vicinity of industries, sampling methods other than for dustfall should be considered, such as with sampling bags, adsorption tubes and impinger trains. This might permit a more complete analysis of the cause and nature of the air pollution problems involved.

FIGURE 3

TOTAL DUSTFALL

OSHAWA, STATION: 45014

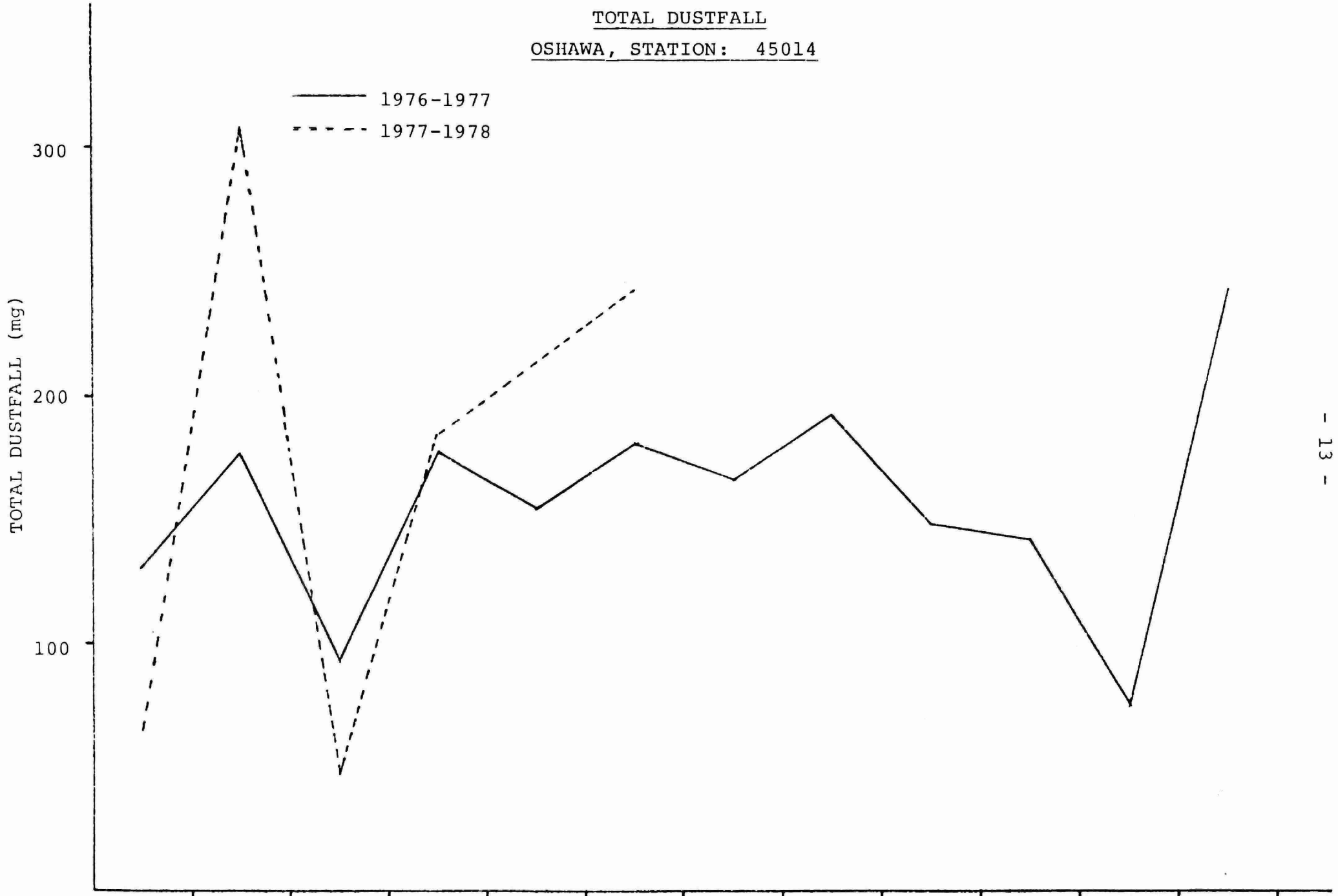


FIGURE 4

TOTAL DUSFTALL

OSHAWA, STATION: 45015

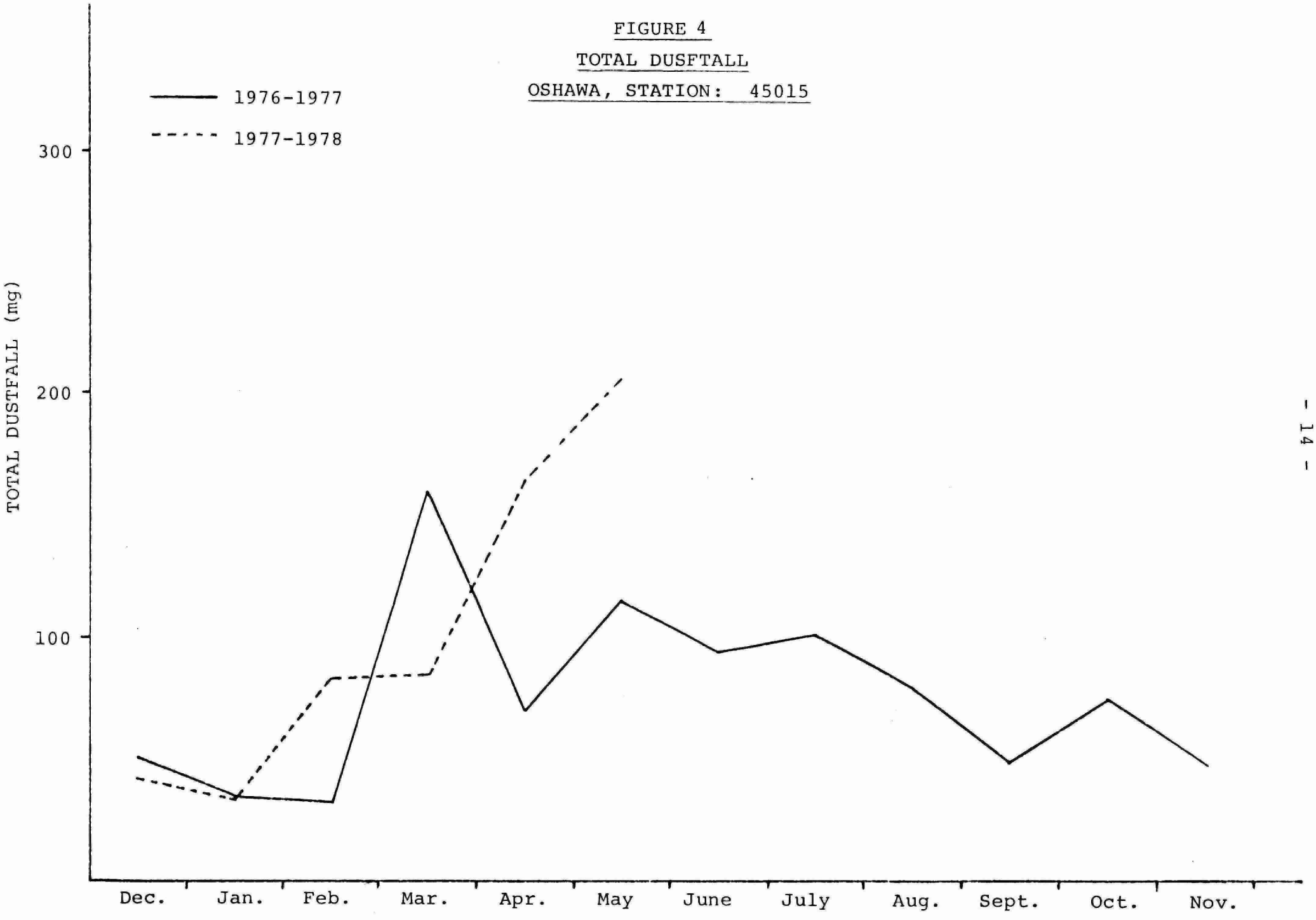


FIGURE 5

TOTAL DUSTFALL

OSHAWA, STATION: 45019

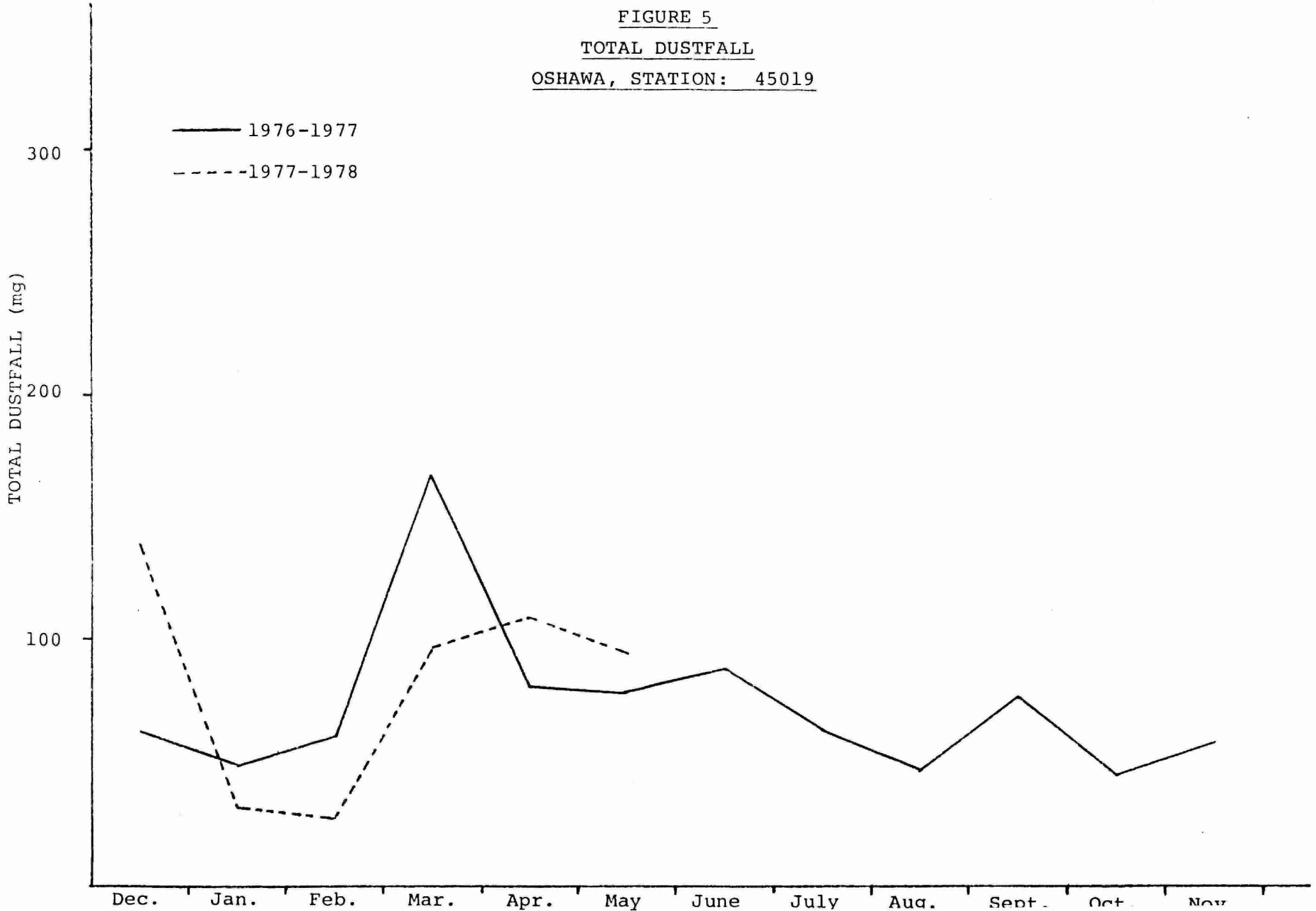


FIGURE 6

BSO IN DUSTFALL

OSHAWA, STATION: 45014

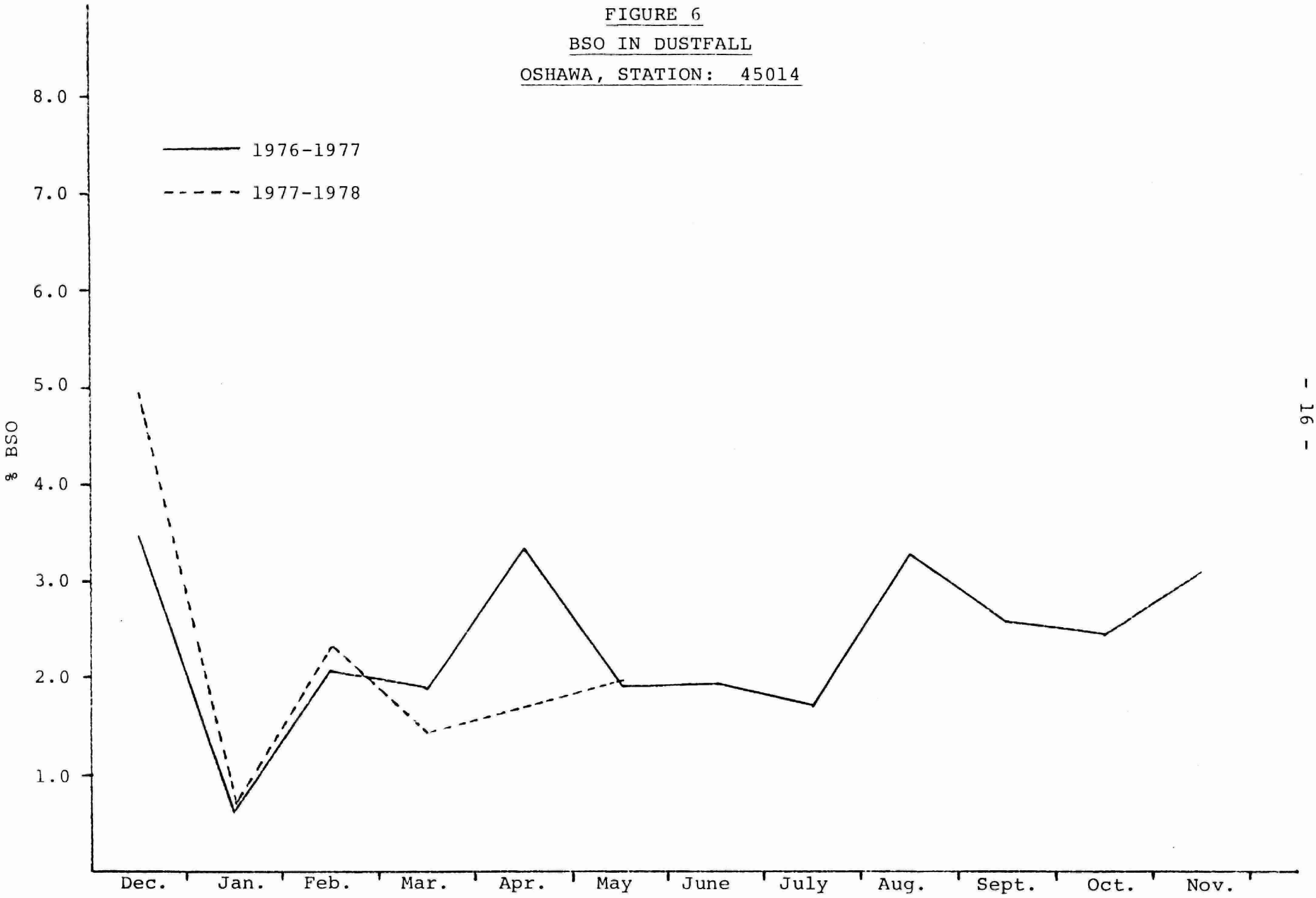


FIGURE 7

BSO IN DUSTFALL

OSHAWA, STATION: 45015

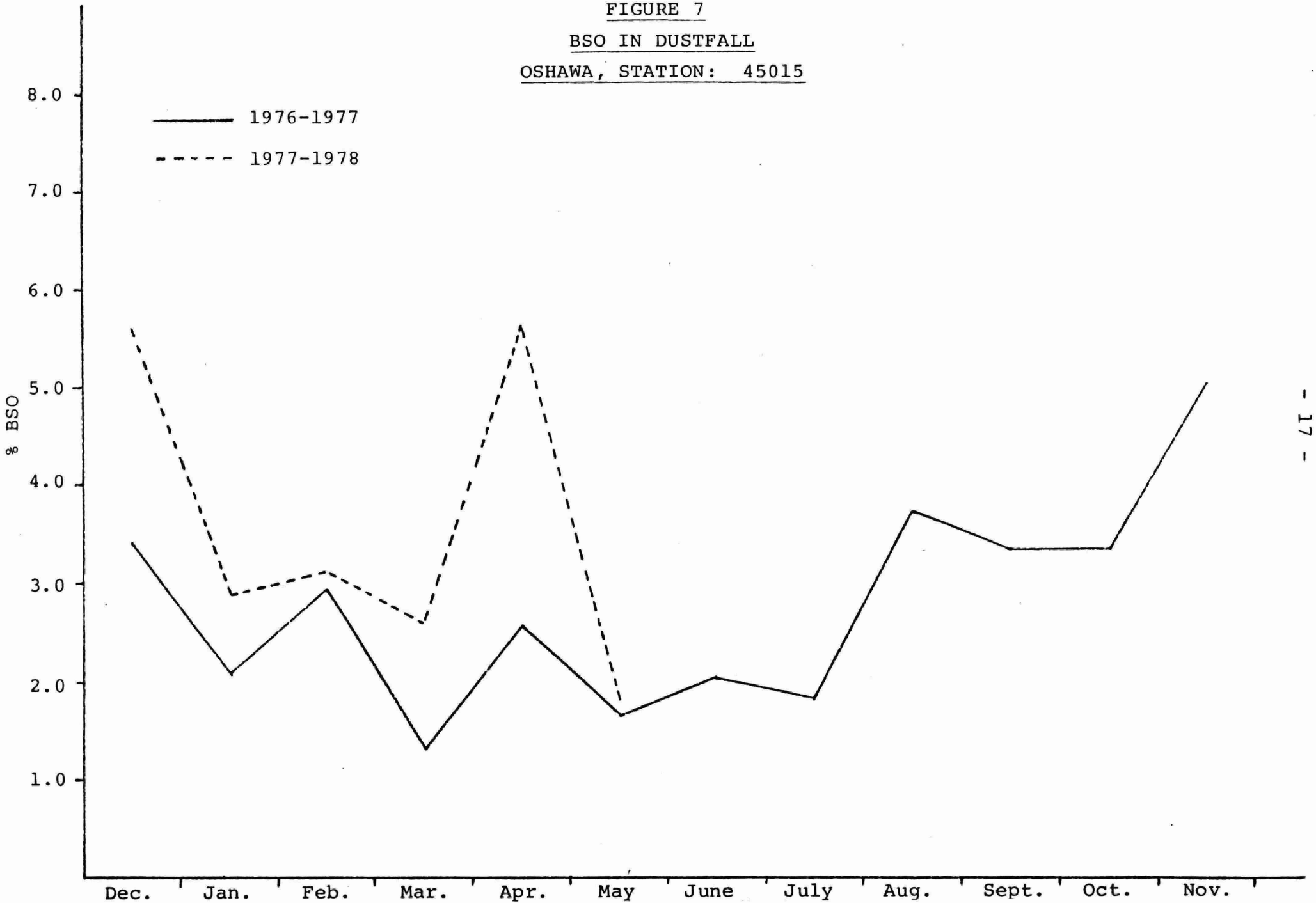


FIGURE 8

BSO IN DUSTFALL

OSHAWA, STATION: 45019

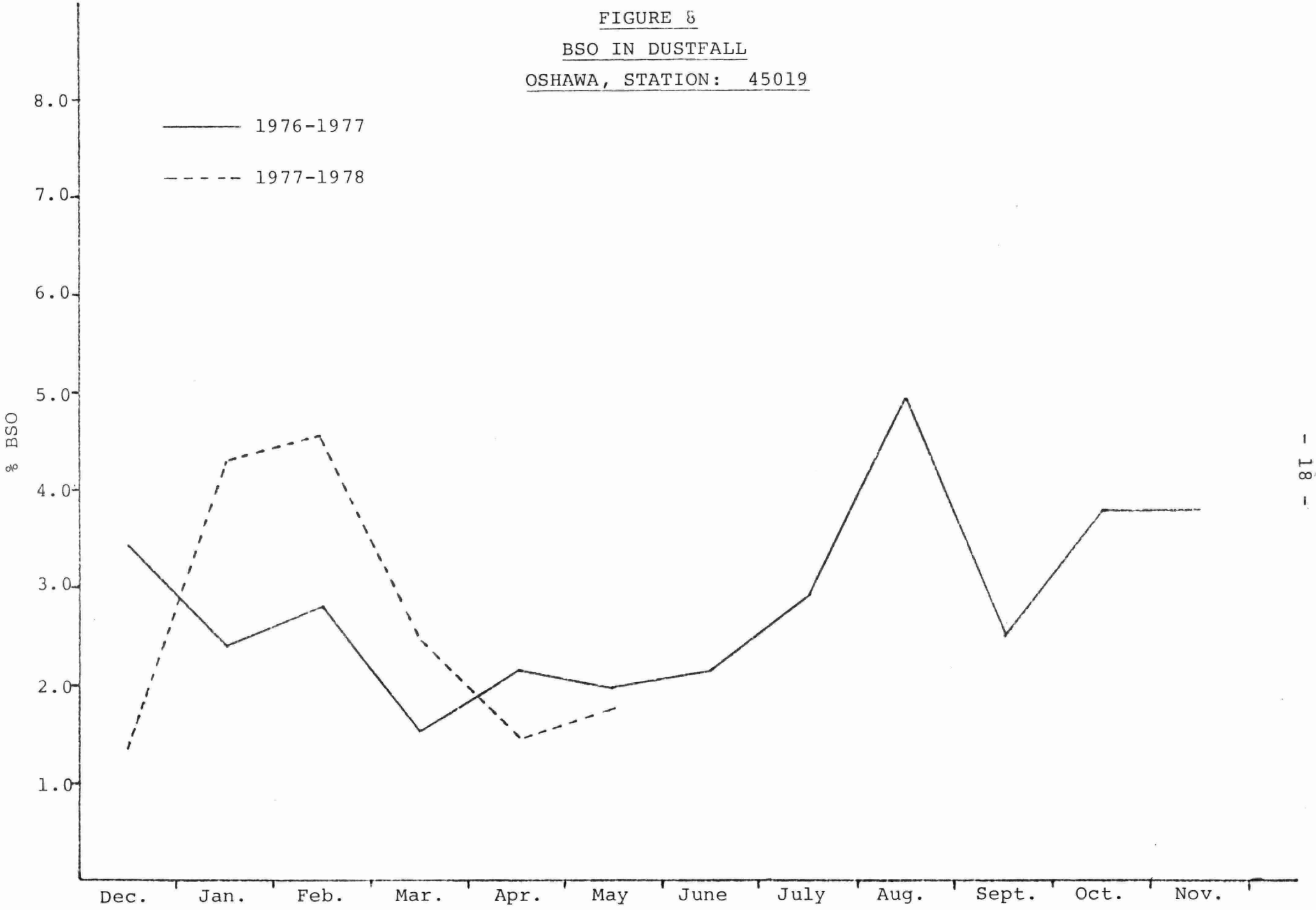


TABLE 1

BENZENE SOLUBLE ORGANICS IN DUSTFALL

OSHAWA, STATION: 45014

SAMPLING MONTH	TOTAL VOLUME (ml)	TOTAL DUSTFALL SOLIDS (mg)	TOTAL BSO	
			mg	% (of solids
12/76	465	130.4	4.50	3.46
1/77	730	176.8	1.08	0.61
2/77	920	92.4	1.92	2.08
3/77	700	177.4	3.36	1.89
4/77	710	154.5	5.14	3.33
5/77*	280	180.2	3.45	1.92
6/77	560	166.1	3.23	1.94
7/77	450	192.3	3.33	1.73
8/77	650	148.7	4.89	3.29
9/77	1680	142.1	3.64	2.56
10/77	540	74.1	1.82	2.45
11/77	1510	243.5	7.60	3.10
12/77*	1440	64.4	3.20	4.97
1/78	1040	309.6	2.23	0.72
2/78	310	46.5	1.08	2.33
3/78	550	183.5	2.65	1.45
4/78	No sample available			
5/78	200	242.5	4.71	1.94

* Insoluble Portion Only

TABLE 2

BENZENE SOLUBLE ORGANICS IN DUSTFALL

OSHAWA, STATION: 45015

SAMPLING MONTH	TOTAL VOLUME (ml)	TOTAL DUSTFALL SOLIDS (mg)	TOTAL BSO	
			mg	% (of solids
12/76	364	50.2	1.70	3.38
1/77	475	35.5	0.73	2.06
2/77	920	32.2	0.95	2.93
3/77	700	159.1	2.08	1.31
4/77	610	70.3	1.81	2.58
5/77*	260	115.2	1.91	1.66
6/77	470	94.0	1.92	2.04
7/77	440	100.7	1.83	1.82
8/77	610	79.1	2.96	3.74
9/77	2040	49.3	1.65	3.35
10/77	530	74.5	2.49	3.34
11/77	1860	48.9	2.47	5.04
12/77*	1520	21.7	1.21	5.58
1/78	1040	33.9	0.97	2.85
2/78	275	83.4	2.61	3.12
3/78	510	84.6	2.17	2.56
4/78	200	164.5	9.25	5.62
5/78	200	206.4	3.80	1.84

* Insoluble Portion Only

TABLE 3

BENZENE SOLUBLE ORGANICS IN DUSTFALL

OSHAWA, STATION: 45019

SAMPLING MONTH	TOTAL VOLUME (ml)	TOTAL DUSTFALL SOLIDS (mg)	TOTAL BSO	
			mg	% (of solids
12/76	503	62 9	2.17	3.44
1/77	730	49.3	1.19	2.41
2/77	800	60.8	1.69	2.79
3/77	800	167.3	2.53	1.51
4/77	600	80.6	1.72	2.14
5/77*	305	78.6	1.54	1.96
6/77	690	88.1	1.89	2.15
7/77	730	63.9	1.87	2.92
8/77	660	47.2	2.33	4.93
9/77	1840	77.7	1.96	2.52
10/77	505	45.2	1.72	3.80
11/77	1900	58.3	2.22	3.81
12/77	1840	139.0	1.85	1.33
1/78	1180	31.9	1.36	4.27
2/78	305	27.5	1.25	4.55
3/78	575	97.1	2.41	2.48
4/78	120	109.3	1.60	1.46
5/78	200	95.3	1.68	1.76
		OSHAWA, STATION: 45035		
3/78	500	873.4	5.05	0.58
4/78	160	269.3	1.83	0.68
5/78	200	242.6	2.48	1.02

* Insoluble Portion Only

FIGURE 9

TOTAL DUSTFALL

CHATHAM, STATION: 13004

FIGURE 10

TOTAL DUSTFALL

CHATHAM, STATION:13005

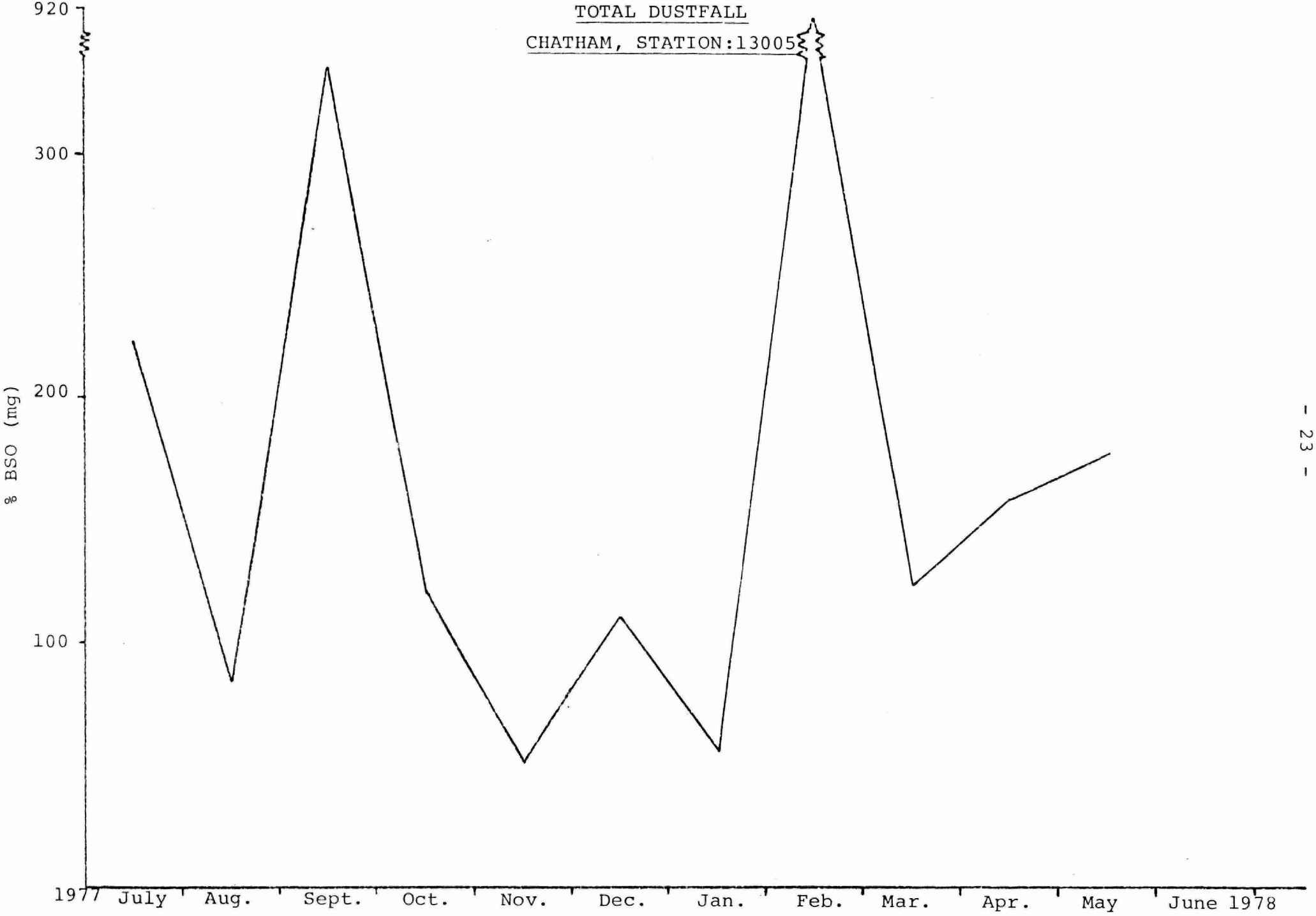


FIGURE 11

BSO IN DUSTFALL

CHATHAM, STATION: 13004

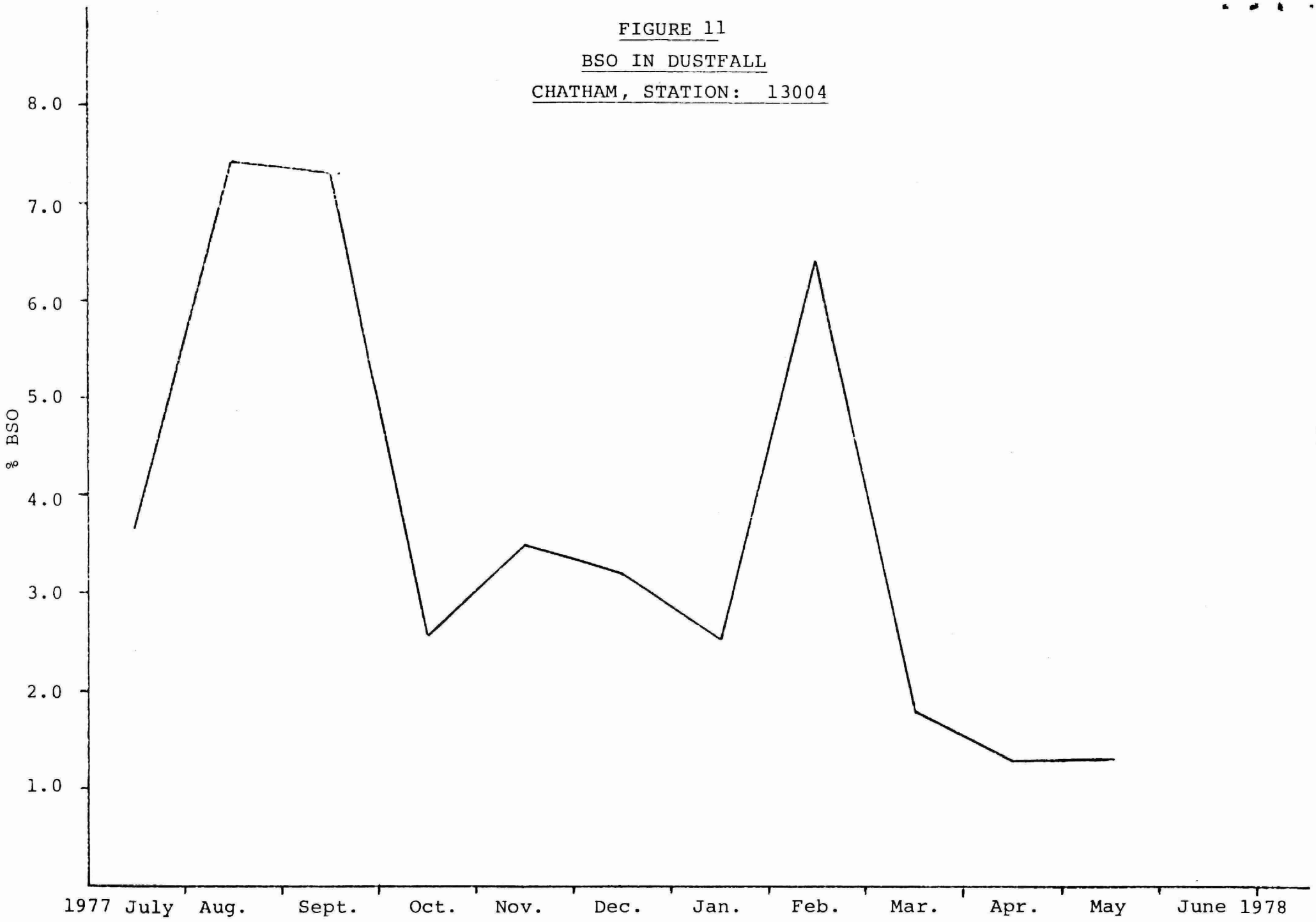


FIGURE 12

BSO IN DUSTFALL

CHATHAM, STATION: 13005

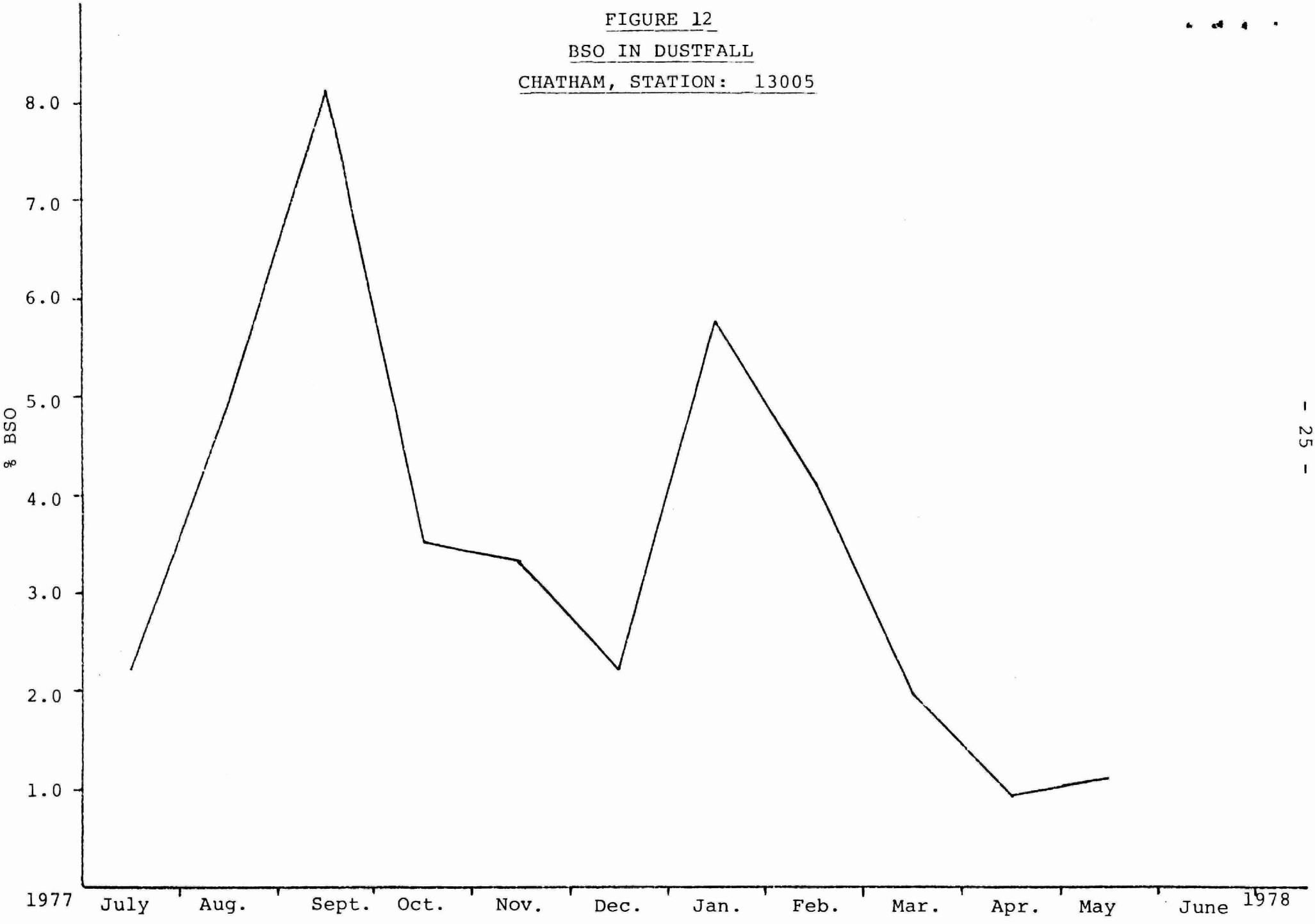


TABLE 4

BENZENE SOLUBLE ORGANICS IN DUSTFALL

CHATHAM, STATION: 13004

SAMPLING MONTH	TOTAL VOLUME (ml)	TOTAL DUSTFALL SOLIDS (mg)	TOTAL BSO	
			mg	% (of solids
7/77	710	200.5	7.28	3.63
8/77	345	98.3	7.30	7.42
9/77	2560	109.8	8.01	7.30
10/77	500	62.4	1.59	2.54
11/77	1120	44.3	1.54	3.47
12/77*	1720	52.3	1.67	3.20
1/78	1380	54.0	1.36	2.51
2/78	500	17.0	1.09	6.41
3/78	1170	116.9	2.06	1.76
4/78	200	168.9	2.17	1.28
5/78	200	210.3	2.73	1.30

* Insoluble Portion Only

TABLE 5

BENZENE SOLUBLE ORGANICS IN DUSTFALL

CHATHAM, STATION: 13005

SAMPLING MONTH	TOTAL VOLUME (ml)	TOTAL DUSTFALL SOLIDS (mg)	TOTAL BSO	
			mg	% (of solids
7/77	490	222.9	4.95	2.22
8/77	440	84.7	4.17	4.92
9/77	1900	335.2	27.3	8.15
10/77	395	119.1	4.18	3.51
11/77*	760	51.6	1.72	3.33
12/77	1440	110.6	2.47	2.24
1/78	1220	56.4	1.29	5.77
2/78	475	917.2	37.9	4.13
3/78	660	122.7	2.46	2.00
4/78	200	158.6	1.48	0.94
5/78	200	177.3	1.97	1.11

* Insoluble Portion Only

TABLE 6

SUMMARY OF RESULTS

DUSTFALL STATION	TOTAL VOLUME (ml)	TOTAL DUSTFALL SOLIDS (mg)	TOTAL BSO	
			mg	% (of solids)
45014				
Max.	1680	309.6	7.6	5.0
Min.	200	46.5	1.1	0.6
Average	749	160.3	3.4	2.3
45015				
Max.	2040	206.4	9.3	5.6
Min.	200	21.7	0.7	1.3
Average	724	83.5	2.4	3.0
45019				
Max.	1900	167.3	2.5	4.9
Min.	120	27.5	1.2	1.3
Average	794	76.7	1.8	2.8
13004				
Max.	2560	210.3	8.0	7.4
Min.	200	17.0	1.1	1.3
Average	946	103.2	3.4	3.7
13005				
Max.	1900	917.2	37.9	8.2
Min.	200	51.6	1.3	0.9
Average	744	214.2	8.2	3.5

TABLE 7

PAH IN BENZENE SOLUBLE ORGANICS (BSO)

STATION	SAMPLING MONTHS	BSO ng	BaP ng	BaP %	BkF ng	BkF %	B(ghi)P ng	B(ghi)P %	FLUORANTHENE ng	FLUORANTHENE %	PERYLENE ng	PERYLENE %	TOTAL OF 5 PAH ng	TOTAL OF 5 PAH %
45014	Dec./76	4,502,000	700	0.016	500	0.011	600	0.013	2280	0.051	900	0.020	4980	0.111
45014	Jan./77	1,081,000	55	0.005	55	0.005	55	0.005	220	0.020	100	0.009	485	0.045
45015	Dec./76	1,695,000	45	0.003	48	0.003	40	0.002	112	0.007	103	0.006	348	0.021
45015	Jan./77	731,000	45	0.006	40	0.005	20	0.003	80	0.011	45	0.006	230	0.031
45019	Dec./76	2,168,000	155	0.007	125	0.006	120	0.006	500	0.023	320	0.015	1220	0.056
45019	Jan./77	1,186,000	90	0.008	66	0.006	50	0.004	300	0.025	200	0.017	706	0.060

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